

of the current and the voltage, to obtain photographs of the tendons, and possibly the muscles; for the photographs which I have already obtained show great contrasts, and there are indications of muscular layers and tendons. The contrast between the bones and the flesh is extraordinary, much greater than in the X-ray pictures usually obtained by the Rhumkorf coil.

The investigator, by means of the liquid resistance, can keep the tube at the same point of excitation. For the scientific study of the X-rays nothing seems better adapted than this large battery plant which I have had constructed, and it is not impossible that a smaller plant of the same number of cells, but with less capacity, may be desirable for large hospitals.

The first step in an investigation of the X-rays is to obtain a steady source of these rays: one of the essentials for the accomplishment of this is a steady current which can be regulated. This, I believe, I have secured. The next step will be the proper control of the amount of gas in the tube. At one time I believed that an oscillatory discharge was necessary for the strongest manifestation of the rays. My experiments, however, with a steady current have shown me that an oscillatory discharge is not essential; such a discharge could not take place through the large resistance which I used—4,000,000 ohms. Such are some of the results which can be obtained by the use of this large battery.

THE CRUISE AND DEEP-SEA EXPLORATION OF THE "SIBOGA" IN THE INDIAN ARCHIPELAGO.

THE annual summer meeting of the Netherlands Zoological Society, which was held in Amsterdam on July 1, was of more than usual interest on account of the fact that it was attended by all the members of the scientific staff of the *Siboga* expedition, who returned only a few weeks before from their one year's cruise in the different basins of the Indian Archipelago, during which they covered a distance of about 12,000 sea miles, *i.e.* about half the circumference of the globe. The track, as indicated on the accompanying Fig. 1, commenced at Soerabaja on March 7, 1899; it ended in the same port on February 27, 1900. The vessel, which is a cruiser belonging to the Dutch Royal Navy, was on its first trip, and before its departure was specially fitted up for the work of the cruise, both with a sounding apparatus of Le Blanc and of Lucas, with some 20 kilometres of wire rope for dredging purposes, and with all modern appliances for pelagic fishing, for plankton collection and for deep-sea work (a "sondeur à clef" of the Prince of Monaco, apparatus for obtaining sea-water from given depths according to Petterson and Sigsbee, Hensen's nets, &c.)

It may here be mentioned that very thorough experiments were made with Mr. G. H. Fowler's net, which is specially intended for plankton from given depths, and which can be opened and shut at will at any moment. About this net, which is of very recent invention, and which has as yet only been used by Mr. Fowler himself, and perhaps on board the *Valdivia*, the members of the *Siboga* expedition are very enthusiastic. It is most trustworthy in its results and fruitful in its catches.

The leader of the *Siboga* expedition, Prof. Max Weber of Amsterdam, well-known by his former expeditions to the East Indies, to the far north and to South Africa, was accom-

panied by Madame Weber-van Bosse, herself an accomplished naturalist, who made a very complete collection of Algae during the cruise, and who settled three very important points as a result of the observations made, *viz.*: (1) the presence in unexpected quantities of calcareous Algae (Lithothamnion) in the Archipelago, so that they build up reefs of considerable dimensions, in depths of 3 to 40 metres, in one case even at 120 metres. Different circumstances of level, current, &c., must co-operate to render the occurrence of Lithothamnion in such quantities possible: the expedition found them realised in at least thirty different localities, and henceforth the possible contribution of Lithothamnion-remains to the formation of the earth's crust will in many cases have to be reconsidered by the geologists. (2) The presence of a minute vegetal organism about which of late years English and German naturalists have considerably differed in opinion: the Coccosphere. Neither the members of the German Plankton nor those of the *Valdivia* expedition have succeeded in satisfying themselves that these miniature spheres with adherent discs of lime, already known in the Cretaceous



FIG. 1.—Track of the *Siboga*.

period and everywhere present on the bottom of the sea, are organisms and not inorganic concretions or sediments. Mm. Weber has now succeeded in demonstrating the truth of the contrary, and has found this very lowly organised alga in great abundance, and entirely agrees with Mr. George Murray's statements concerning the alga-nature of the coccospheres; she has even found in this alga green chromatophores, and has seen phases of division of the spheres; (3) the presence of shell- and rock-perforating algae, a group hitherto neglected in the tropics, of which she has brought home a great number.

The zoological collections of the *Siboga* are very extensive, both those collected on the coral-reefs and from the very different depths. Deep-sea animals were met with at depths of about 150 fathoms, where they would hardly have been expected, but where their presence is explained by certain hydrographical circumstances to be mentioned later. Porifera, and among them the most diverse Hexactinellids, were exceedingly numerous. East of the Aru Islands, gigantic

specimens of *Adeona* were captured. This curious Bryozoarian, of leaf-like shape and attached to a segmented stem, has sometimes been considered as one of the *Isidinae*.

Of the curious solitary Alcyonarians, the *Haimeidae*, which up to now are known as small specimens from the Red Sea and from Algiers, a species of a very considerable size has been met with. *Amphianthus*, an absolutely flat Actinian, was found on the shell of a *Dentalium*, and amongst the numerous Echinoderm-finds material abounds to definitely settle the question about the regeneration and the so-called comet forms of *Linckia*. It could be demonstrated that the regeneration takes place, without any part of the disc being preserved, from a bare arm-fragment. On these *Linckias* the parasitical molluscs, *Thyca* and *Stylifer*, were often present. Various *Solenogastres* were captured, and many interesting Cephalopods. The fish collection is also very considerable, and a great many deep-sea forms are among them, of which a specimen of *Ruvettus* attains to a size of several feet.

The most beautifully transparent larval *Muraenas* were at the other end of the scale, and were also exhibited at the meeting. Both they and other pelagic organisms, *Medusae*, *Heteropods*, &c., were most successfully preserved in formalin. On the whole the preservation of all the specimens, for which the most various methods were employed, is first-rate; and Mr. Nierstrasz, to whose supervision this had been more especially entrusted, received due recognition of his merits on this head. Some hundred bottles of plankton have yet to be sorted and worked out. Dr. Versluys communicated to the meeting the results of investigations into the amount of oxygen contained in the sea-water at different points which he had made during the cruise, and Prof. Weber called attention to certain hydrographical results of primary importance obtained by the expedition.

The gist of these is that the communication between the deep water of the Indian and Pacific Oceans and that of the Archipelago basins is very different from what it was expected to be. The different straits between the lesser Sunda Islands, Bali to Flores, are none of them deep enough to allow of any horizontal passage of the deeper and colder strata (where the temperature is 0.9°C .) into the Banda basin and its continuations between Flores and Timor and between Flores and Celebes. These undoubtedly receive their cold bottom-water from the Pacific Ocean by way of the deep communications indicated on the map to the north of Buru (the so-called Ceram sea), which opens out into the Pacific by a narrow passage (the so-called Moluccan passage). In the deep spurs, to which the name of Bali and Flores sea may be given, the expedition could actually demonstrate the existence of a bottom-current which flows westward and which brings the cold water from the Banda sea into these recesses where the supply from the Indian Ocean through the numerous straits is only superficial and restricted to surface-water of a temperature of more than 12°C . The cold bottom-current of 3°C . just alluded to, which slowly flows westward out of the Banda sea, even rises up along the sloping coasts of the Kangeang-Paternoster-Postillon islands (not indicated on the map) situated north of this deep sea spur, as could be demonstrated both by serial temperatures and even by the net, which, as mentioned above, brought up deep-sea forms from comparatively shallow water, just because of this bottom current, which, being hemmed in, flows towards the surface.

The temperature of 3°C . referred to above is the uniform minimum temperature for the whole of the Banda basin below the depth of 1600 m., and the theoretical conclusion that no deeper communications than this exist with either of the Oceans was practically verified, and also (as indicated above) that the cold water of the greater depths comes from the Pacific and not from the Indian Ocean.

The Banda Sea, *sensu strictiori*, was further found to be different from what was hitherto held. On charts, mention is made of a depth of 7000 metres (4000 fathoms) in the neighbourhood of Banda. This depth has been demonstrated by the *Siboga* to be due to some error, the depth being nowhere below 5500 metres, and the basin itself being most unexpectedly intersected by two shallow ridges, clearly visible on the map, the more westward of which has been named the Siboga Ridge. Geological speculations concerning this part of the earth's crust will undoubtedly be influenced by these results.

For the distribution of deep-sea animals, the difference of a couple of degrees between the bottom-water of these basins and that of the oceans will certainly not have much importance;

and even the ridges will in the long run prevent only very few deep-sea animals from penetrating into the basins in the course of generations, when the difference of pressure can be slowly neutralised. At all events, the catches did not justify expectations that these enclosed deep basins might harbour a deep-sea fauna which, by its isolation from the ocean, had developed into peculiar local deep-sea faunas particular to those basins.

The hydrographical work of the expedition has thus been of very considerable importance, and will soon be also noticeable in improved navigating charts for the regions explored. Even geographical corrections of considerable amount are amongst the results of the cruise. The south coast of the large island of Timor (of which the eastern half is a Portuguese, the western a Dutch possession) will have to undergo a radical alteration, as indicated on the accompanying sketch (Fig. 2). Thus the *Siboga* expedition has not inconsiderably reduced the colonial surface area of Portugal, having anchored in spots which, according to the present maps, lie far inland.

The expedition can thus be complimented on having achieved a most successful piece of work, and it is undoubtedly in the first place due to the undaunted energy of the leader, Prof. Weber, and to the exemplary skill of the officer in command of the vessel, Comm. Tydeman, who for many years has already been one of the leading hydrographers in the Archipelago. The liberality of the Naval Department, and its active co-operation in all that pertained to the expedition, have been especially noticeable.

The results, both hydrographical, botanical, zoological and geological, will, as soon as possible, be worked out by different

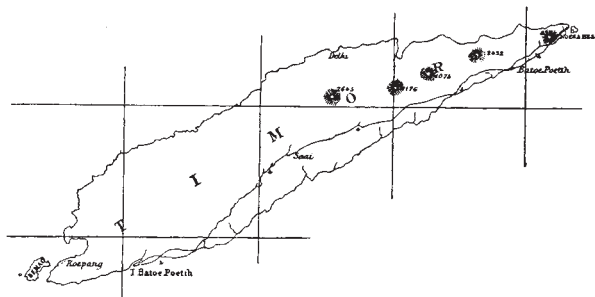


FIG. 2.—The coast-line of Timor. The outside southern coast-line is as indicated upon current maps; the inner line shows the true coast-line as determined by the *Siboga*.

specialists, and be brought together in a series of well-illustrated quarto volumes, the number of which is roughly estimated at about fifteen. Several specialists, both Dutch and foreign, have already promised to co-operate, and what with Alcock's researches in the Bay of Bengal, the *Valdivia's* exploration of the Indian Ocean, the Australian investigations of the Barrier Reef and the Torres Straits, the Belgian Antarctic expedition, and Agassiz's dredging expeditions in the Pacific, we can safely say that, by the time this publication will have appeared, we will have obtained a very thorough knowledge of an important portion of the abyssal regions, towards the exploration of which the *Lightning*, *Porcupine* and *Challenger* have set the example, and the *Blake*, *Albatross*, *Travailleur*, *Talisman*, *Gazelle*, *Vettor Pisani*, *Willem Barents*, *Hirondelle* and *Princesse Alice* have so considerably contributed from other parts of the globe.

A. A. W. H.

EXPERIMENTATION ON EMOTION.

OF points where physiology and psychology touch, the place of one lies at the phenomenon "emotion." Built upon sense-feeling much as cognition is built upon sense-perception, emotion may be regarded almost as a "feeling"—a "feeling" excited, not by a simple unelaborated sensation, but by a group or train of ideas. To such compound ideas it holds relation much as does "feeling" to certain species of simple sense-perceptions. It has a special physiological interest in that certain visceral reactions are peculiarly concomitant with it. Heart, blood-vessels, respiratory muscles and secretory glands